


# ENERGY

**Abstract:** Energy is critical to the vitality and endurance of a nation's economy, fueling all industries and supporting military, diplomatic, informational and economic instruments of power. Energy is the only industry sector addressed in the U.S. National Security Strategy. Ensuring the security of America's energy resources is challenging due to our dependency on foreign fuel sources, especially oil and gas. This dependency is caused by a predominate use of fossil fuels, the large reserves of fossil fuels located outside the United States, a lack of adequate infrastructure to move natural gas and oil from pump to consumer, environmental and political restrictions within the United States, and a relatively minor U.S. surge capability to counteract geopolitical realities. As our domestic supply production decreases, projected increases in economic growth will drive increases in demand, which must be increasingly met through imported sources. This reality makes policies that promote international trade and diversity in fuel types and sources the cornerstone for energy security. Our study incorporates issues and findings from the countries we visited: Canada, Britain, and Spain. We found that the energy industry is not in crisis; however, U.S. government policies, laws, dollars, and even public awareness campaigns must be used to increase energy security.

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## PLACES VISITED:

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE <b>2003</b>		2. REPORT TYPE <b>N/A</b>		3. DATES COVERED <b>-</b>	
4. TITLE AND SUBTITLE <b>2003 Industrial Studies: Energy</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>The Industrial College of the Armed Forces National Defense University Fort McNair Washington, DC 20319-5062</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release, distribution unlimited</b>					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>UU</b>	18. NUMBER OF PAGES <b>28</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			

Washington, DC	Aramco Services Company	Oil and natural gas
Frederick, MD	BP Solar	Photovoltaic panel manufacturing
Charlottesville, VA	H2GEN Innovations, Inc.	Hydrogen generation
Washington, DC	Department of Energy	National Energy Policy, renewables, electricity, fuel cells, distributed generation
Frederick, MD	Mirant Mid-Atlantic, LLC	Coal power generation
Martinsburg, WV	CONSOL Energy	Coal mine
Washington, DC	The Brookings Institution	Corporate Average Fuel Economy (CAFE) standards
Washington, DC	D.C. Government Fleet Management	Compressed natural gas vehicles
Washington, DC	Electric Drive Transportation Association	Electric and hybrid vehicles
Washington, DC	The Natural Gas Vehicle Coalition	Compressed natural gas vehicles
Washington, DC	New York Mercantile Exchange	Commodity trading
<b>Canada</b>		
Vancouver & Coquitlam	U.S. Consulate Generals	U.S. Embassy
Calgary, AB	National Energy Board	Regulatory board
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Fort McMurray, AB	Synchrude Canada	Oil sands
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Vancouver, BC	Powerex Corporation	Power marketing and trading

Barcelona, Spain	El Garraf Plant	Methane extraction from recycling
Barcelona, Spain	Barcelona Port Authority	LNG marine terminal visit
Barcelona, Spain	Catalan Institute of Energy	Catalan energy oversight
Barcelona, Spain	Barcelona Energy Center	Energy information center
Barcelona, Spain	U.S. Consulate General	Commerce brief
Madrid, Spain	Central Nuclear de Trillo 1	Nuclear generation, waste storage
Madrid, Spain	Endesa	Electric utility
Madrid, Spain	Unesa	Electricity association
Madrid, Spain	U.S. Embassy	Energy brief
Madrid, Spain	Repsol-YPF, SA	Petroleum - upstream, downstream
Madrid, Spain	CEIMAT (Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas)	Research and development

International:

## **INTRODUCTION**

Energy is vitally important to our nation's security. As a fundamental resource, energy is integral to every other industry. Barring any improvements in energy efficiency, increases in Gross Domestic Product (GDP) involve concomitant increases in energy consumption. The GDP of the United States is expected to increase by three percent per year between the years 2001 and 2025.<sup>[1]</sup> Since energy consumption moves in tandem with economic growth, consumption is projected to increase by 1.4 % per year for non-transportation sectors and two percent per year for the transportation sector.<sup>[2]</sup> Availability of affordable energy resources is a prerequisite for national economic viability and prompts national energy security initiatives.

The history of energy as a *vital national interest* can be traced to the 1970's oil shortage and Arab oil embargo that prompted President Carter to name access to energy resources (i.e. oil) a vital national interest. Energy is the only industry and commodity delineated as a vital national interest in the National Security Strategy. The National Energy Policy published in May 2001 emphasizes a market-based approach to energy security through diversity in fuel source, by type and origin, and including investment in new technologies that will lessen dependence on fossil fuels.

This paper summarizes our findings from this semester-long study of the energy industry and explores issues influencing the industry today. We will begin by describing the industry and end with a discussion of issues. Our conclusions and policy recommendations were developed from lectures, readings, independent research, and reflects the insights we gained during domestic (United States and Canada) and foreign (Britain and Spain) industry visits.

## **SCOPE**

America's demand for energy is the largest in the world at 24% of the world's consumption. The United States consumed 97 quadrillion British Thermal Units (QBtu) in 2001 of the nearly 400 QBtus consumed around the world – more than twice as much as the next closest country, China, which used 40.4 QBtu.<sup>[3]</sup> Energy use in the aggregate generally increases with population growth. Increases in economic prosperity generally increase use per capita. Energy intensity, energy per dollar of GDP, has declined in the United States since the 1970's due to technological advancements that have improved energy efficiency.<sup>[4]</sup> Total primary energy supply in the United States in 2001 was more than 3,800 million tons of oil equivalent (mtoe), with imports of 600 mtoe, or 16%, primarily oil and gas.<sup>[5]</sup> America's reliance on imports has grown since the 1960's and is projected to continue to grow to 36% in 2025.<sup>[6]</sup>

The industry consists of four sectors. The largest energy user is the industrial sector, which uses one third of total energy, followed by transportation, 28%; residential, 21%; and commercial, 18%.<sup>[7]</sup> Energy resources comprise fossil fuels, including coal, oil and natural gas; nuclear power; and green or clean sources, such as hydro, solar, wind, fuel cell, and fusion. The following sections define the energy resources and highlight trends and issues facing the industry today.

## **COAL**

Coal-fired electrical generation is the cornerstone of electricity security in the United States. As the most abundant natural fuel source, coal produces more than 50% of the nation's electricity, and 37% of the world's electricity.<sup>[8]</sup> Recoverable coal reserves at producing mines in the United States are estimated at 17,800 million short tons, which is only six percent of total estimated U.S. reserves<sup>[9]</sup> and 26% of estimated world reserves.<sup>[10]</sup> It is widely agreed that there is enough coal to last several hundred years into the future. We import only 1% of our coal and export 4% (mostly with Canada).<sup>[11]</sup> Despite a worldwide abundance of coal, its use is largely regional due to the high cost of transport.

Canada produces enough coal to fuel its internal demand although geographic imbalances create import and export trade with the United States.<sup>[12]</sup> Coal is a primary fuel source for extracting oil from oil sands, pending completion of a natural gas pipeline from the MacKenzie Delta to replace it eventually as a more economical choice. Both Britain and Spain are trying to phase out coal in order to meet Kyoto Protocol targets. Nonetheless, Britain is meeting its current demand internally. Spain imports coal to generate 42% of its electricity.<sup>[13]</sup>

### ***Trends & Challenges***

Availability of coal and low production costs have made coal a predominant energy resource – a trend expected to continue through 2025.<sup>[14]</sup> However, coal production is not expected to increase at the same pace as projected demand because of environmental and investment pressures. Low natural gas prices, coupled with an environmental push away from coal, lessen its competitiveness in the market. Natural gas is the emerging preferred resource, but still lags significantly in its contribution to electricity production. Coal competes with natural gas if gas prices increase.

Coal production is a capital-intensive business with a significant cost allocated to safety and environmental regulations. Competition in the coal industry has pushed out smaller, higher cost producers in favor of those that can survive through economies of scale. Aided by technology, coal production doubled since 1923 while the workforce shrank by 90% from more than 700,000 to 75,000 in 2002.<sup>[15]</sup> The coal industry, with its aging workforce shaped by unionism, competes poorly against “cleaner”, higher-tech industries in attracting new, quality, skilled workers.

One of the biggest challenges to coal use is environmental pressure for clean air. Coal is the dirtiest of the fossil fuels, emitting 506 million metric tons of carbon dioxide in 2001.<sup>[16]</sup> Stricter emissions regulations will reduce the percentage of coal usage in the total energy mix, even though coal production will increase. To maintain competitive pricing in the market and utilize a richly abundant fuel source in spite of environmental pressures, the Department of Energy is conducting significant research and development (R&D) into clean coal technology (CCT). The CCT program is a government to private industry partnership that seeks to find ways to use coal in environmentally friendly ways. The combined commitment is \$5.8B for technological solutions in: environmental control devices, electric power generation, coal processing for clean fuels, and industrial applications.

<sup>[17]</sup> Positive results from collaborative efforts have already improved efficiency and reduced hazardous emissions in coal production.

## **OIL**

As a *vital national interest*, oil is a focal point for security. The Middle East is the center of gravity for oil supply, therefore access and secure geopolitical relationships are critically important. Diminishing supplies of this natural resource put it at the center of potential conflict if access is denied. The challenge for the United States and other nations is to develop interdependencies that strengthen energy supply security and prevent conflict.

Oil industry activities are traditionally divided into:

- Upstream oil – the process of exploration, extraction, and transportation of crude to refineries, and
- Downstream oil – the process of refining, marketing, transporting, and retailing refined products. Refined products include gasoline, diesel fuel, heating oil, jet fuel, lubricants, plastics, tires, and more.

The upstream oil industry is essentially an oligopoly dominated by the Organization of the Petroleum Exporting Countries (OPEC), which is controlled by Saudi Arabia, holder of the world's largest oil reserves. But other non-OPEC players control significant reserves, including Canada whose oil sands are validated at 15% of world reserves, and Russia, with 5% of reserves.<sup>[18]</sup> Non-OPEC countries are becoming more important players in the world market by increasing their production. The implications of this impacts world oil supply and infringes on OPEC control. The downstream oil industry represents a classic commodity business characterized by a high volume of processed oil and low profit margins in a highly competitive environment.

### ***Trends & Challenges***

World oil demand is projected to increase from 76 million barrels per day (mmb/d) in 2001 to 123 mmb/d by 2025.<sup>[19]</sup> Though industrialized countries like the United States will continue to demand more fuel, there will be a sharper rise in demand from developing nations as they grow more rapidly into the 21<sup>st</sup> century. Proven world reserves, currently at 1.2 trillion barrels of oil,<sup>[20]</sup> continue to grow as a result of new exploration and advancing technologies. For example, technology recently enabled economical extraction of oil from Canada's oil sands, thereby adding new proven oil patches to the world's reserves. Three-dimensional (3-D) seismic technology that enables deeper, more accurate drilling is finding more reserves and improving the efficiency of oil drilling. Thus, world supply will likely meet growing demands into the foreseeable future.

As the nation's largest source of primary energy, oil supplies nearly 40% of U.S. energy demand, with transportation fuels accounting for about two-thirds of consumption and the industrial sector, for 25%.<sup>[21]</sup> During the next 20 years, U.S. oil consumption is expected to increase 33% while production is expected to decline, yielding an increase in imports.<sup>[22]</sup> Today, the U.S. imports over half of its crude oil with 24% coming from the Middle East, 22% from South America, and 16% from Canada.<sup>[23]</sup> Saudi Arabia is the price setter within OPEC for petroleum and is currently the United States' largest crude oil supplier. However, when refined petroleum products are included, Canada becomes our largest supplier.

U.S. public lands, like the Arctic National Wildlife Reserve (ANWR), have petroleum resources that are off-limits to drilling for political and environmental reasons. Though technology has reduced the environmental damage of drilling, there is still much debate over this issue that weighs domestic oil supply against protecting the natural environment.

Refineries meet 90% of internal demand for refined products, with projections for adequate capacity for the next 10 to 15 years.<sup>[24]</sup> With no new refineries planned for construction, the United States will become more, not less, reliant on imported refined petroleum products.<sup>[25]</sup> Canada is poised to meet this increased demand with high quality products from their new oil patches.

Refinery margins are impacted by the costs of environmental regulations that require a variety of fuel types, called boutique fuels. Boutique fuels pose a challenge for production. The specificity for a niche market is somewhat inefficient and precludes wide distribution of common fuel. Fuel standardization would increase energy security by increasing supply availability of more common, multi-purpose fuels. The Department of Defense employs such a standardization policy, which greatly

enhances efficiency and supply access through local procurement or storage of standard, common use fuels.

## **NATURAL GAS**

Natural gas, abundant globally and domestically, offers energy versatility among various economic sectors. Cleaner burning than coal or oil, natural gas is the fuel of choice to mitigate environmental concerns. The natural gas industry comprises exploration, production, transportation and infrastructure.

The United States leads the world in volume of production at 500 million barrels of oil equivalent per day (mboed), or 22.5% of world production, and is the leading consumer worldwide at 555 mboed, 25.6% of world consumption.<sup>[26]</sup> However, only 3.3% of the world reserves are found in the United States, while the Middle East, Eastern Europe and the Former Soviet Union hold 72% altogether.<sup>[27]</sup> U.S. natural gas accounted for 27% of energy produced and 24% of U.S. energy consumed in 2000.<sup>[28]</sup> The United States meets 83% of domestic natural gas demand through indigenous resources, with the remainder being met through pipeline imports from Canada, at 16%, or by liquefied natural gas (LNG) tankers from several nations around the world including Algeria, Nigeria, Trinidad and Tobago.<sup>[29]</sup>

### ***Trends & Challenges***

The natural gas share of electricity generation is projected to increase significantly because natural gas fired generators have lower capital costs, higher fuel efficiency, shorter construction lead times, and lower emissions than coal fired generators. Natural gas is also thought to be the bridge fuel from coal to clean energy-producing technology. Because production in the lower 48 states is declining, exploration remains a high priority.

New technology, primarily 3-D Seismic, has significantly improved the success rate of finding and extracting gas and oil reserves. While the new drilling technology doubled drilling costs in the 1990's, it increased production by 300-700%.<sup>[30]</sup> Technology also made possible the recovery of large quantities of coal bed methane, 6% of today's natural gas production.<sup>[31]</sup>

Natural gas is characterized by large price fluctuations and natural gas wells that tend to be exhausted within a few years. The substantial lag time between the market signal for increased demand change and increased production creates price volatility. Price volatility discourages new investment in infrastructure.

The problem for America is not the lack of gas, but rather the lack of the infrastructure to transport the supply to end users at competitive prices. The National Energy Policy report recognized the aging and inadequate pipeline network as part of the challenge of repairing and expanding our energy infrastructure.<sup>[32]</sup> LNG is expected to play an increasing role in energy markets in the next several years. But construction and location of LNG receiving terminals face investment, safety and not-in-my-backyard (NIMBY) concerns.

A second challenge is land access -- a barrier to domestic supply. Between untapped reserves and undeveloped resources, the federal government manages land, onshore and offshore, containing nearly 770 trillion cubic feet of natural gas -- enough to supply the entire nation for 30 years.<sup>[33]</sup> However, as with oil, current leasing policies prevent extraction of natural gas from most federally owned lands.

## **NUCLEAR**

Nuclear power contributes to American national security by providing diversity and self-sufficiency. The 103 nuclear power plants in the United States provide a clean, stable, secure source of

low-cost electricity that does not emit any greenhouse gases.<sup>[34]</sup> Nuclear power provides 20% of the nation's electricity and about 17% of the world's electricity.<sup>[35]</sup> Estimates indicate that use of nuclear power plants avoid more than 620 million tons of carbon dioxide emissions from fossil fuel-powered plants each year.<sup>[36]</sup> However, in spite of the positive aspects of nuclear power, there are also very significant issues that constrict the industry, including: investment; licensing and regulation; waste storage and public perception.

### **Trends & Challenges**

Although no new plants have been built since 1978, increased efficiency of nuclear power plants resulted in production rising by 25% from 1990 to 2000.<sup>[37]</sup> No new plant construction is forecast through 2025, meaning that production increases can only come from efficiencies in existing plants. High construction costs, licensing, regulation and liability issues have reduced investment in nuclear power. As a result of Congressional criticism, the Nuclear Regulatory Commission (NRC), safety regulators for nuclear power, have developed new standard licensing procedures to eliminate delays, reduce costs, and mitigate risks to potential investors.<sup>[38]</sup>

The Achilles heel of the nuclear industry is the storage of its radioactive waste. U.S. policy on such waste calls for it to be isolated and stored in a deep, underground repository that remains geologically undisturbed for thousands of years. Congress approved the Yucca Mountain waste repository in Nevada, with a projected opening date of 2010. However, opposition threatens to stall this project. For now, plants continue to store waste at reactor sites.<sup>[39]</sup> On-site storage is the preferred option for Spain, where above ground storage has been approved for 40 years at the Trillo power plant in Spain.

At the heart of the nuclear energy debate is polarized public opinion. On one side are those who defend nuclear power's safety record, and on the other side are those whose criticism rests on isolated, historical events. Public opposition slows the progress of technology and investment, even in refurbishing or adding to existing plants. Nuclear power remains controversial because of the 1979 Three Mile Island (TMI) accident and the 1986 Chernobyl disaster. But according to an analyst at DOE, the likelihood of something being worse than TMI is "extremely low, since nuclear energy collects and handles fewer radioactivity particles in one year than produced in one day with chemical wastes."<sup>[40]</sup> The Chernobyl plant would not have been licensed in the United States because it lacked a proper containment structure.<sup>[41]</sup> A study by the Electric Power Research Institute validates the safety of nuclear plant structures to threats from terrorist attacks.<sup>[42]</sup> The challenge to attracting investment and political support is to inspire public confidence in the safety of nuclear power and strict enforcement of safety standards.

New construction of nuclear power plants is on hold in many countries, including Europe and Canada, as they face many of the same challenges with investment, waste storage and public opposition. However, Spain may reconsider its 20-year moratorium on nuclear power because nuclear power is essentially its only non-imported energy source.<sup>[43]</sup>

### **RENEWABLE SOURCES**

Renewable energy sources add diversification and reduce emissions. Renewable energy sources include wind; solar; biomass and biofuel; hydrogen; tidal generation; geothermal and hydroelectric. Each is at a different stage of development in terms of energy efficiency and affordability. For example, while hydroelectric technology is mature, some sources such as hydrogen and tidal power are still in the R&D phase. The National Energy Policy supports development and wider use of renewables and hydrogen. The European Commission has gone further by setting a tangible goal for the European

Union of 12% of total energy supply from renewables in 2010, up from 6% today, and Britain's White Paper on energy sets a target of 10% by 2010. <sup>[44]</sup>, <sup>[45]</sup>

### ***Trends & Challenges***

Comprising five percent of the total primary energy supply, renewables produce about nine percent of America's electricity, with hydroelectric producing seven percent. <sup>[46]</sup>, <sup>[47]</sup> Non-hydro renewables generally cost more than fossil fuels. However, rising fossil fuel prices and growing environmental consciousness will lead consumers and businesses toward renewable energy as an alternate fuel source.

Of all renewables, wind shows the most promise in the near-term. Though wind only provides 0.5% of America's energy today, it could increase to 12% over the coming decade. <sup>[48]</sup> The United States has the most wind capacity, followed by Germany, then Spain. Solar power technology – both photovoltaic cell (PV) and thermal – also continues to improve, but PV cells are expensive to produce and require a high capital outlay.

Hydrogen has the potential to be a safe, pollution-free and economical energy source. But, with technology in the developmental stage, there are many challenges to converting the United States to a hydrogen economy, such as building new production and distribution centers, and developing small, efficient hydrogen fuel cells. President Bush's \$1.7 billion proposed subsidy for hydrogen research over five years is a start, but more funding will be needed. <sup>[49]</sup>

Today, most renewables are more expensive than fossil fuels. For renewables to be viable in the marketplace, R&D must deliver technologies that are cost-competitive with oil, gas and coal. Less expensive hydrogen production, distribution, and storage technologies must be developed if hydrogen is to compete with fossil fuels. Finding an environment-friendly, economical feedstock for hydrogen will be challenging. While natural gas is now the primary fuel for hydrogen, the demand in other sectors may raise concerns about the ability of the nation's natural gas infrastructure to meet rapidly expanding demand.

## **ELECTRICITY**

The U.S. electric power industry, accounting for \$250B in revenues, consists of generation, transmission and distribution. <sup>[50]</sup> Coal produces more than 50% of U.S. electricity, followed by nuclear - 20%; natural gas - 19%; hydroelectric - 7%; petroleum - 2%; and renewable resources (wind, biomass, solar, underground steam) - 2%. <sup>[51]</sup> Generation is becoming increasingly deregulated, and more progress is anticipated in the years ahead. However, the transmission and distribution systems are inadequate and will not support complete deregulation in the near term. Deregulation of the electricity industry is one of the most significant factors influencing how electricity is traded. An essay at the end of this paper addresses this topic in detail.

### ***Trends & Challenges***

Electricity rates for all sectors have steadily declined since deregulation began in 1978. <sup>[52]</sup> The cost among sectors varies depending on usage time and season. Since the residential sector is more expensive to service and demand is concentrated during peak usage periods, rates for the residential sector remain relatively high compared to rates for the industrial and commercial sectors.

One challenge for the U.S. and the rest of the world is balancing the often competing and conflicting demands for electricity, as well as for environmental protection. This issue is discussed in an essay later in this paper.

Another challenge in the electricity industry is infrastructure of the transmission grid, which is over-burdened and in great need of maintenance and update. The seriousness of this problem is

illustrated by millions of dollars lost each year to power outages in the United States, many of which are caused by inadequate transmission capacity. The International Energy Newsletter, June 2003, highlighted, with alarm, the U.S.'s low investment in transmission and distribution, predicting degraded power systems if infrastructure spending is not increased. <sup>[53]</sup>

The long term solution is distributed energy, which sites electricity production closer to customers. Distributed energy relies on geographic collocation of energy resource for generation or stored energy – both of which are difficult to achieve. Stored energy in the form of electricity is not practical, except in hydroelectricity where energy is stored in water reserves. The idea of distributed energy through hydrogen fuel cells is being explored by companies we visited: H2Gen in Alexandria, VA is developing a hydrogen generator designed to fuel up to 20 cars with hydrogen, and Ballard in Canada is developing a hydrogen fuel cell designed to work as emergency backup power source. This next-generation technology is not yet cost competitive for general use.

## **OUTLOOK**

Energy, and fossil fuels in particular, will continue to be of vital interest to the U.S. and global economies. World consumption will increase in correlation with economic growth. U.S. consumption is expected to grow at a rate of 1.5% per year to 139.1 QBTu by 2025, while imports nearly double from 26 QBTu. <sup>[54]</sup> Fossil fuels will continue to dominate the supply mix, with natural gas overcoming coal. Spurred by EU directives, Europe will develop renewable fuel sources to a greater extent than the United States.

Continuing the trends of the past decade, energy companies will continue to restructure by merging and consolidating into global energy super companies. With interests and holdings stretching around the world, these companies will become bigger players in international policy arenas, aided by their interactions with nation states and NGOs. Our national energy security will depend upon an understanding of new roles, relationships and the influences of multinational corporations whose reach extends into regions where diplomacy is unable to work against instability caused by political, economic, or religious issues.

Looking internally at the U.S. energy sector, our findings include the following characteristics of energy's future:

- The United States will continue to rely on imported petroleum products with the realization that energy independence is not possible.
- Coal will continue to be the major fuel source of electricity in the United States until it is surpassed by natural gas in the year 2005. <sup>[55]</sup>
- The short-term outlook for natural gas calls for continued high prices driven by supply shortages, depleted stored gas, and declining domestic production that will lead to more imports, mainly from Canada. LNG imports will increase as cost becomes more competitive. <sup>[56]</sup>
- The MacKenzie Delta and Alaska gas pipelines will both be built, but not at the same time. Natural gas from Canada's Northwest Territories will fuel oil sands production or Canadian consumption before transportation to U.S. markets.
- The electricity industry is expected to grow efficiently at 1.8% between now and 2025. <sup>[57]</sup> Nuclear power plants will continue to generate more electricity in the near term based on increasing the efficiency of current nuclear plants. The role for coal and renewable sources will depend on future legislation at both the federal and state levels. New generation will be mainly from gas-fired plants.
- In the long run, distributed energy will resolve some transmission and distribution problems, however, transmission infrastructure is a problem of increasing urgency. Cross border electricity transmission grids will expand, creating both security and vulnerability.
- Renewables are expected to grow in importance, with some predicting that they may provide up to

60% of the world's energy by 2060.<sup>[58]</sup> With enough public, business and government investment, many believe the United States could convert to a hydrogen economy within the next 20 years.

The world will not run out of energy. Yet, the frequency of regional shortages and supply disruptions will worsen, which in turn, could interrupt economic growth. Industrial nations' dependency and diversity of energy imports will increase as domestic sources diminish. Alternate production centers will emerge with geopolitical, economic, and social implications in places such as Canada, Russia, the Caspian Sea region, and Africa. Uneven distribution of resources, more frequent supply interruptions, and respective political, economic and social ramifications will increase the potential for conflict over the competition for energy. As a result, nations will be forced to rethink geopolitical relationships.

Demands for a clean environment in conjunction with economic growth will increasingly challenge global consumption trends. While clean energy technologies will continue to make great strides, the bulk of nations will not meet standards of the Kyoto Protocol and will renegotiate another standard. Nations will increasingly turn to natural gas to lower emissions. Alternatives to natural gas will be found in nuclear power, investment in clean coal technology, hydroelectric power, and in the long run, hydrogen. The changing dynamics of the energy industry require the involvement of nations, multinational energy corporations, and governments – the subject of our next section.

## **GOVERNMENT ROLE AND POLICY RECOMMENDATIONS**

Governments play a significant role in the energy industry by developing policies and legislation that addresses security, safety and the environment. A large governmental role is not surprising given the linkage between energy, national security and economic prosperity. National sustainability and development depend on access to energy supply, the security of which is addressed in the U.S. National Security Strategy.

The importance of energy to government is clear. The European Union, which is founded on a treaty designed to redistribute coal in attempts to deflect an economic recession,<sup>[59]</sup> is a primary, long-standing example. Declining indigenous supplies force trade as an option to resolve geographic imbalances between supply and demand. U.S. and EU energy policies address the lack of supply and the importance of viable trade relationships in open markets.

Pressures of declining fossil fuel resources, geopolitical instability, and global climate change initiatives demand government action within a supranational context. Indeed these issues and liberalization have culminated in recently released national energy policies of the nations we studied:

- The U.S. National Energy Policy (NEP) – “reliable, affordable, and environmentally sound” -- was released on May 16, 2001. While the National Energy Act is still under debate in Congress, funding for energy initiatives has been proposed and approved in the President's budget. NEP goals address conservation, infrastructure, supplies, environment and energy security.
- The European Community released its latest communication on the development of energy policy for an enlarged EU on May 13, 2003,<sup>[60]</sup> following a November 2000 Green Paper – “Let us overcome our dependence.”<sup>[61]</sup> European Union directives drive policies for member nations, including Spain. Spain's Cabinet approved a 10-year energy plan in September 2002 that still awaits approval of the Parliament.<sup>[62]</sup> Spain's plan is in two parts: one part addresses regulated infrastructure development and the other addresses liberalization in private industry. EU Green Paper goals of secure energy supplies, a single European energy market, and environmental protection are included.
- The United Kingdom (UK) released its energy policy in an Energy White Paper, signed by Prime Minister Tony Blair in February 2003. A document of guidance without specific implementation

ideas, the White Paper proposes an aggressive 60% reduction of carbon dioxide (CO<sub>2</sub>) by 2050 through conservation, renewable energy, emissions trading and efficiency.<sup>[63]</sup> Other goals include reliability of energy supply, competitive markets, and affordable heat for all citizens.

- Natural Resources Canada, an element of the federal government, oversees national energy policies. Jurisdiction over energy resources is decentralized at the provincial government level. Canada's goals revolve around promoting a competitive energy market, secure reliable supplies, and participation in global environmental initiatives. It is interesting to note that Canada's market view is defined as North America, with a clear view toward meeting rising U.S. demand.

Economic forces merge with national and supranational diplomacy to fill domestic shortages in energy supply from geographic centers around the world. New geopolitical relationships are forming as a result with new players, such as Kazakhstan or Nigeria, in potentially unstable regions while the Middle East continues to dominate the supply side of the equation. Internal trade is equally important, as demonstrated by the EU single energy market, designed to resolve energy chokepoints, including cross-border electric grids like those existing between the United States and Canada. When the market is unable to provide solutions, government action is necessary. The discussion below describes and recommends government actions we found appropriate from our study.

**Security.** Nations vary in their organization and approach, but all generally agree that diversity is the key to energy security, and that diversity can be attained through open energy trade in fuel types from multiple sources. Since dependence on imports is a certainty for all the nations we studied, security can only be achieved through diversity in supply and source. Government diplomacy and policy that facilitate positive relationships and promote open market energy trade are required to ensure such security. A failure here would invite influence from the military instrument of power.

**Environmental Pressure.** Perhaps the biggest impact on energy policy in the last decade is the emergence of international environmental initiatives. Launched from the 1992 UN Framework Convention on Climate Change and solidified in the 1997 Kyoto Protocol, environmental emission reduction targets direct a reduction in energy emissions, which have a second order effect of reducing economic activity. More explanation of this issue is offered in an essay later in this paper.

**Investment.** Another role for government is funding R&D when lack of profitability dissuades private investment, as is the case for expensive research in renewable technology. As technology evolves toward feasible solutions, transfer to private companies achieves implementation in the market. Spain exercises such government support in *CIEMAT*, a public research institute providing leading edge research into fusion, solar and wind technology.<sup>[64]</sup> We recommend that the U.S. government incentivize R&D through partnerships in public and private institutions, providing funding where market forces fall short.

**Regulation.** Regulated activities such as transmission, distribution and pipelines that do not operate under the free hand of the market need government involvement to ensure access by both suppliers and consumers and to prevent supply chain bottlenecks that lead to energy failure. We recommend U.S. government incentives be used to encourage private investment and deregulation where market forces will allow competition.

Legislation that protects federal land prohibits the nation from realizing its full indigenous resource capacity. As technology enables more environmentally friendly drilling, we recommend the U.S. continue to explore oil and gas reserves on federally protected land and promote extraction when market forces allow.

Regulation that sets clear, consistent standards in energy production is a responsibility of the government. Safety standards protect workers in dangerous energy industries. Environmental standards

promote production changes and stabilize the investment outlook for energy companies in transition to cleaner technology. Standardization in refined fuel products promotes efficiencies in refineries, lowers fuel costs to consumers, and enhances fuel availability.

Achieving independence is not a realistic goal for the United States or the nations we visited. The industrialized world faces similar challenges in developing their economies inside the pressures of the environment and diminishing resources. Global energy trade interdependencies create a global energy security that will be important to our national energy security.

Before reaching our overall conclusions, we will examine three topics of special concern in the energy industry: energy and environmental issues; our ability to surge or quickly increase production capacity of energy; and deregulation or restructuring of the electricity industry.

## **ESSAYS ON MAJOR ISSUES: Environment, Surge Capacity, and Deregulation**

### **Environmental Issues Weigh Heavy on Energy – Karen Dyson, Colonel, U.S. Army**

The most pressing factor influencing the energy industry today is the environment and the international climate change initiatives. Most energy today is produced from burning fossil fuels that emit greenhouse gases. Many scientists claim these emissions cause global warming and other detrimental effects. Although energy production is a regional issue, clean air and climate change are global problems that can only be solved through worldwide efforts. The impact on the energy industry is direct -- a resource shift away from coal toward natural gas as the bridge fuel source, which ultimately will be replaced by clean or green fuel sources. Adaptation of processes to meet environmental standards is costly, and raises the question of who should pay. This essay explores environmental issues as they impact the energy industry.

#### ***The issues – background and definition***

Studies in the 1970's and 1980's, aided by computer modeling technology, forecast that global growth would eventually outpace available resources.<sup>[65]</sup> This research led to the concept of *sustainable development*, which called for environmental accountability to address the companion issues of depleting resources and the pollution resulting from economic growth. The trigger for international action was the 1992 UN Framework Convention on Climate Change (UNFCCC) in Rio de Janeiro, a platform to address environmental degradation caused by unequal energy consumption among industrialized and developing nations.

The subsequent Kyoto Protocol was recognition by the international community that enforceable standards were needed to implement global action against climate change. By all account of government officials familiar with the negotiations who met with our seminar, the targets were unscientifically and hastily decided upon during midnight sessions in a quest to take action within the international framework. As such, the targets have been called to question for their arbitrariness and failure to take economic impacts into account. Targets were set to reduce absolute amounts of emissions against 1990 levels.

#### ***Trends***

The Kyoto reporting mechanism measures six greenhouse gases, of which energy related carbon dioxide (CO<sub>2</sub>) constitutes more than 82%.<sup>[66]</sup> Trends in CO<sub>2</sub> emissions correlate positively with trends in energy consumption. The United States, with the largest economy in the world, is the largest polluter, ranking ahead of the European Union, Russia and China.<sup>[67]</sup>

Since 1990, overall U.S. CO<sub>2</sub> emissions have increased by an average of 1.3% annually (about the same as GDP growth), driven by factors of weather, fuel sources for power generation, and the

economy.<sup>[68]</sup> Additionally, long-term factors include population growth and income. As energy consumption per capita has increased, so have CO<sub>2</sub> emissions per capita, rising about 3.5%

above 1990 levels, with a drop in 2001 due to economic slowdown.<sup>[69]</sup> Energy efficiency reflected in the decrease in the energy intensity (i.e. energy consumption per GDP dollar) also translates into a corresponding decrease in CO<sub>2</sub> intensity (CO<sub>2</sub> emissions per GDP dollar), down 15.8% in 2001 from 1990.<sup>[70]</sup>

### ***The problem with Kyoto***

The approach outlined in the Kyoto Protocol calls for reducing absolute quantities of emissions against 1990 levels. As greenhouse gas (GHG) emissions directly correlate to economic activity, this translates into a mandated economic recession. The United States, in not ratifying the Protocol, acknowledged two problems: 1) cost to the economy is too high; and 2) the Protocol includes only developed nations in the solution. Developing nations, such as China, with the most rapid projected economic growth, are exempt. Since the product of Kyoto is clean air, and clean air is a global public commodity, clamping down on emissions in developed nations while allowing developing nations to increase their emissions will not reach the desired result.

The U.S. approach uses GHG intensity (emissions per GDP dollar) as a metric in addressing climate change. Initiatives for Global Climate Change proposed by President Bush in 2002 commit the United States to reducing GHG emissions through a market-based approach. The aggregate reduction target is 18% emissions intensity by 2012.<sup>[71]</sup> The FY03 President's budget reinforces this commitment in the highest allocation ever to environmental and natural resources (\$44B).<sup>[72]</sup>

### ***Who plays and who governs?***

The international framework calls on economies to participate in a collaborative process to implement climate change. In this arena, the United States, as an economic leader, plays a dominant role whether or not a ratifier of the Kyoto Protocol. Our demonstrated participation in emission reduction programs is essential to our political credibility within the international community.

Our travels exposed us to other nations who have ratified the Kyoto Protocol: Canada agreed to a six percent reduction and Britain and Spain, under the EU umbrella, ratified an eight percent reduction. Predictably, the government officials we spoke to supported their national decision for ratification although implementation details are still hazy. Private industry and academic leaders we spoke to were more skeptical, acknowledging that Kyoto is not achievable without severe detrimental impact to national economic and corporate prosperity. The general conclusion was that Kyoto is destined for retooling toward a more realistic, market-based intensity metric, similar to the U.S. model.

Private industry, the third player, has two reasons for concern about government actions. One is the cost of regulation. Corporations are shifting to natural gas for efficiency and for environmental reasons as they anticipate the costs of government regulation. The coal industry is perhaps the most affected by climate change as it burns the dirtiest fossil fuel and is subject to the costliest environmental scrutiny.

A second perspective is one that looks forward toward development of alternate fuel sources, including renewable and clean sources. Some companies are investing in R&D in hopes of getting ahead of the technology and gaining a future competitive edge. British Petroleum (BP), which was the first company to publicly set emissions reductions goals for itself and meet them ahead of schedule, is investing in solar technology as a way to get inside the changing industry.<sup>[73]</sup> BP's model seeks "to make renewable energy sources economically attractive as well as environmentally attractive."<sup>[74]</sup> Some technologies, such as fuel cells, are insufficiently developed to draw corporate investment and rely on private investors and the government.

According to the international framework, climate change is the responsibility of nation states for policy and regulation toward action. Governments set standards and makes funds available for initiatives that the market won't support. Clean air, a public commodity, is generally not paid for through market forces. Participation by the U.S. government could include: technology transfer or fund donation to support the international community; taxes as an incentive or disincentive to influence behavior; subsidies to develop clean, green technology; and public information campaigns to encourage conservation and ease transition to newer technologies.

### ***Recommendations***

The U.S. stance on Kyoto is clear, as is the U.S. commitment toward reducing GHG emissions. There is an opportunity for the United States to offer leadership within the international framework by setting an example of an-intensity based metric system that works. To do this, it is important that measurable progress be achieved, documented, and reported. If not, the United States loses credibility as global perception pegs the world's largest economy as an irresponsible contributor to the problem, but not to the solution.

Secondly, the problem of climate change is indisputably global. The United States must participate in programs that support clean fuel development in developing nations. The primary funding mechanism for this is the Global Environment Facility, to which the United States pledged \$500M over four years.<sup>[75]</sup> Though the largest amount in dollars, it is quite low in terms of percent of GDP. As with other international aid programs, the United States must consider the adequacy of this donation.

The government must fund emerging technology that is not yet marketable. Major initiatives in the current administration include fuel cell, clean coal, and fusion technology – when developed, these will lead to clean energy production. Partnerships with academic institutions and private corporations to share knowledge and resources can push research and development forward. But, the government must be willing to stimulate the development through funding where the market falls short.

### ***Conclusion***

Climate change is a much-debated topic, as research and modeling that make projections hundreds of years into the future are difficult to validate. However, the connection to the energy industry and the economy is clear. The importance to our national security is substantiated by the inclusion of definitions for CO<sub>2</sub> emissions reductions in the U.S. National Security Strategy. Since the nation depends on reliable energy sources to fuel the economy, energy will continue to be of vital interest to our national security. The Kyoto Protocol standards will fail, opening an opportunity for U.S. leadership to demonstrate market-based solutions toward a cleaner environment.

### **U.S. Energy Surge Capability – A Discussion of Acceptable Risks – David Styles, Colonel, U.S. Army**

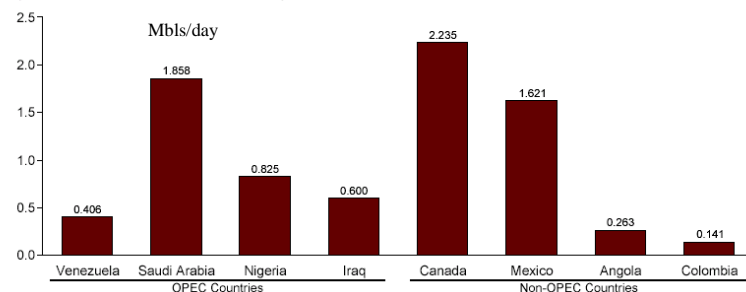
One measure of a nation's power is its ability to quickly surge its human, financial, military, political and natural resources to meet an emerging national crisis (war), emergency (natural disaster), or major impact event (Y2K). Certain resources are generally critical to the basic functions of the national infrastructure and the ability to rapidly respond and recover. The United States has a very limited capability to surge energy -- the lifeblood of the U.S. economy, and the only resource and industry specifically designated as a vital national interest

The U.S. reliance on a free global market to meet its energy needs reflects acceptance of a high degree of risk in its ability to surge energy. The United States has little domestic energy surge capability other than the strategic petroleum reserve (SPR), limited natural gas storage, and to some extent, electricity, to meet immediate demands or threats to security. If global markets were to fail, the nation must currently rely on rationing and conservation methods in response. However, a society can ration

and conserve for only a short period of time before its economy suffers. This essay discusses the various fuels and infrastructures required to sustain the energy industry and recommends government and industry actions to mitigate the risk.

**Oil.** As a result of the U.S. government's concern over access to affordable oil supplies since the 1973 oil embargo, upstream oil, in the form of the Strategic Petroleum Reserve (SPR), represents the nation's only true surge capable energy source. The SPR is a domestic 700 million barrel (Mbl) reserve that the nation can surge into the market at a rate of 1 – 4 Mbls/day for about 4 months. [76] Even though the United States is now more reliant on imported oil than in 1973, it has dramatically diversified the sources from which it imports oil. No longer largely dependent on the Middle East, the United States sources 50% of its petroleum products from reliable North American partners such as Canada and Mexico. [77]

Imports from Selected Countries, January 2003



Source: Department of Energy

U.S. refineries now produce 20% of American needs, but that capacity is slowly dwindling. As a result, the nation must now import refined products while operating domestic refineries at full capacity. Therefore, the nation has nearly no downstream oil surge capacity in case of a disruption of imports or a long-term loss of a domestic refinery.

**Natural Gas.** Natural gas is quickly becoming the fuel of choice for electric power generation both in the United States and abroad. However, significant increases in demand coupled with declining reserves have led to domestic supply shortages and higher prices. Though technology enables more efficient and effective exploration and drilling, extraction is more costly and less productive as mature wells are tapped. Furthermore, large new finds are few in the onshore United States, with Alaska (Prudhoe Bay and perhaps ANWR), the Gulf of Mexico, and possibly coal bed methane representing the last domestic potential for long-term sustainable production. However, all of these sources, while economically feasible, face political or legal and environmental challenges. Consequently, the nation increasingly relies on imports to meet its burgeoning demand for natural gas and, due to a lack of domestic storage capabilities, possesses no national natural gas surge capacity beyond the approximately 15 day supply energy companies hold as reserves. [78]

Canada, a reliable and stable ally, provides nearly all U.S. natural gas imports. With extensive supplies and pipeline systems, Canada could readily surge natural gas to the United States. However, the availability of Canadian natural gas will eventually become constrained as Canadian demand grows. Consequently, the United States will become more dependent on imported liquefied natural gas (LNG) from nations whose geopolitical stability may be in question. The United States has only four LNG receiving terminals in the lower 48, all on the east/Gulf coast, accounting for less than 1% of the nation's natural gas supply. [79] Lengthy construction timelines suggest LNG is not viable for short-term natural gas surge capability. Therefore, future U.S. natural gas surge capability will become progressively more limited unless investment expands infrastructure.

**Electricity.** While not a primary fuel, electricity is critical to the U.S. economy and security.

Downstream oil is another matter completely. Upstream oil has very little use until it is refined into gasoline and other products necessary for every sector of the U.S. economy. Yet, major oil companies have not built a U.S. refinery in 20 years due to NIMBY concerns and low profit margins, and they do not keep large stocks of refined products in reserve.

Deregulation increased the market flow of energy. Regional transmission organizations, such as Pennsylvania, New Jersey, and Maryland (PJM) Interconnection, can internally surge electricity through well-developed power grids. However, the lack of a national transmission grid, the unequal rates of deregulation at the state level, and inadequately connected regional grids limit the capability to surge electricity across the nation. The consequences of the inability to surge electricity nationally were demonstrated dramatically by the California energy crisis in 2000/2001.

The primary fuels used to generate electricity and their respective surge capabilities in order of their contributions are as follows:

- Coal provides more than 50% of base and variable load electricity.<sup>[80]</sup> Though abundant, coal fired plants have a limited surge capability, especially during off peak demand periods when plants are running at less than full capacity.
- Nuclear power contributes about 20% of the base load electricity, running at full capacity 24/7.<sup>[81]</sup> Capability to surge is nonexistent.
- Natural gas provides about 19% of electricity<sup>[82]</sup> and surge issues are discussed above. However, at the generation plant level, natural gas provides a relatively quick, short term, albeit expensive way, to surge in that many power plants have back-up natural gas powered generators. LNG is a second source of surge capability, limited only by LNG infrastructure capacity.
- Renewables or green resources, including solar, biomass, wind, and hydropower, contribute about 9% of electric generation. With the exception of hydro, these electricity sources will not reach maturity for another 10 – 20 years.<sup>[83]</sup> Hydropower has nearly reached its full potential in North America and is heavily influenced by weather and environmental concerns. Therefore, these sources are insignificant and not useful for surge capability.

**Recommendations** – Clearly, the United States incurs a considerably high degree of risk in the lack of energy surge capability. The question is, “Should the United States take steps to mitigate this risk or do we place energy in the same category as other commodities and industries, leaving its supply solely to free global market forces?” Because of our dependency on foreign energy sources, and the nature of the global and national free market economies, eliminating all risk would not be feasible, practical, or acceptable. However, since energy is the primary engine driving the U.S. economy, and is critical to its military power, relegating energy to non-vital interest status would not be in the nation’s best interest either. Therefore, national and state governments should implement the following to further develop the nation’s energy surge capabilities and mitigate the risks:

- Continue to accept risk in refined oil products. Department of Defense maintains strategic military reserves in various fuel sources, which mitigates the risks to the military. In the event of a crisis, supply shortages would increase price and enforce market-based consumption conservation. When market forces prove inadequate, local and national governments would enforce conservation and rationing.
- In the long term, create a natural gas reserve (SNGR). The SNGR could be injected into dry oil caverns for ready access as back up fuel to surge natural gas powered electricity generation
- Continue deregulation of electrical power generation and distribution, while regulating transmission. Expand the national grid by federally funding construction of additional transmission lines that link electrically isolated regions.
- Accelerate the Federal Energy Regulation Commission’s (FERC) ability and authority to approve construction/recertification of coal, nuclear and hydroelectric power plants in order to secure a diverse mix of fuels for electricity generation. This gives the industry the capability and flexibility to surge varying fuel sources in the event of a disruption or emergency.

Electricity deregulation is a central issue to the nation's ability to meet our energy security needs through market forces. The absence of competition in distribution systems has suppressed investment into growing our national electricity infrastructure to keep up with demand. This essay explores the nature of electricity deregulation and makes recommendations for the way ahead.

U.S. retail revenue sales of electricity totaled more than \$250B in 2002 from 3,471 million megawatt hours<sup>[84]</sup> generated from coal, petroleum, natural gas, nuclear power, hydro, and renewables. The transmission grid in the United States, while not a national grid, is interconnected in the east (running from the east coast to roughly the beginning of the Rocky Mountains), in Texas and in the West. Portions of the U.S. grid system are also connected to Canada, and to a limited extent, Mexico.

Regional markets consist of three main elements: generation, transmission and distribution. In 1935 the Congress passed the Public Utility Holding Company Act (PUHCA) to break up the three large electric power holding companies that were responsible for generating approximately half of all the electricity in the United States.<sup>[85]</sup> This legislation set the stage for how the industry would be structured for the next 42 years. PUHCA prohibited utility companies from engaging in other business activities. This prohibition cut non-utilities (companies whose main product was something other than electric power) out of the electricity market.<sup>[86]</sup> Essentially, companies:

- structured themselves in order to serve a defined geographic area;
- became vertically integrated, i.e. they began to own and operate the generation, transmission and distribution of power; and
- were regulated by Public Utility Commissions or other regulatory agencies at state and federal levels.

The passage of PUHCA reinforced the idea that the industry was a natural monopoly. Large economies of scale enabled companies to produce electricity at the point of declining Average Total Costs (ATC). Public Utility Commissions regulated the industry in order to assure increases in supply at lower prices. In short, government intervened in the market in order to ensure that excess monopoly profits were returned to consumers in the form of lower prices and universal service.

In 1978 the Public Utility Regulatory Policy Act (PURPA) was enacted to permit non-utilities to enter the electric power industry. It was passed during the height of the "energy crises" and sought to encourage cogeneration (providing electricity as a secondary output) and renewable resources as alternate sources for electricity.<sup>[87]</sup> PURPA opened the door to a new paradigm – power didn't have to come from large monopolies. Smaller companies could sell power to regional grids if priced to compete with power generated by large companies.

The Energy Policy Act (EPACT) of 1992 ensured this competitive pricing and effectively negated PUHCA. Commonly referred to as the "unbundling" of the electric power industry, large publicly owned companies no longer controlled power generating, transmission and distribution services. Finally, on 24 April 1996 the Federal Energy Regulatory Commission (FERC) issued Orders 888 and 889.<sup>[88]</sup> These orders formally separated the transmission industry from the power industry and provided the basis for the current structure of the entire power industry.

EPACT and PURPA have freed, in an economic sense, most power generation in the United States from federal and state regulation, while the transmission and distribution systems remain highly regulated.<sup>[89]</sup> Moreover, since 1980, average electricity rates for residential, commercial and industrial users have steadily declined in real terms. Residential rates have declined from approximately ten cents per kilowatt-hour in 1980 to eight cents in 2000; commercial rates have fallen by approximately the same amount and industrial rates have declined from approximately six cents per kilowatt-hour to just

over four cents per kilowatt-hour during this period.<sup>[90]</sup>

An aberration to this trend was experienced in California during the energy crisis in 2000/2001. Deregulation of California electricity services resulted in large short term price increases for the following reasons: 1) generating capacity had not increased in more than a decade; 2) the economy (and hence demand for electricity) surged in the late 1990s; 3) the transmission grid (at Path 15, north of San Diego) proved to be insufficient to accommodate increased demand in northern California; 4) a drought in the Northwest and in British Columbia decreased hydro-electric capacity; 5) prices were allowed to float at the wholesale level, while being capped at retail level; and 6) the Enron bankruptcy exacerbated the financial markets.

Electric power deregulation has progressed in each of the three countries that the seminar visited. For example, the “liberalization” of electricity in Spain began in 1998 with a protocol accepted by Spanish industry in 1998. Since that time, Spanish electricity prices have declined by 17%.<sup>[91]</sup> However, Spanish liberalization has encountered some difficulties. For example, electricity reserve margins in Spain declined from 140% of maximum requirements to 101% from 1997 to 2001. Since then, they have recovered to 106%.<sup>[92]</sup> In summary, deregulation in Spain is a “two step forward, one step backward” process, not unlike that found in the United States.

Deregulation has also progressed in Canada. Powerex Corporation noted that they follow the same Standard Market Design (SMD) that is currently backed by the U.S. Federal Energy Regulatory Commission (FERC). This has resulted in a more competitive market and more consistent rules for all transmission users.<sup>[93]</sup>

The Energy Seminar feels that economic deregulation is important in that it will result in a more competitive industry, with lower prices for consumers (residential, commercial and industrial) and higher electricity output for the economy as a whole.

### ***Recommendations***

Draft Senate bill S.475, referred to the Energy and Natural Resources Committee on 27 February 2003,<sup>[94]</sup> would repeal PUHCA and follow the recommendations outlined in the Cheney Report of 16 May 2001.<sup>[95]</sup> As previously discussed, PUHCA was designed to break up large holding companies, setting the stage for the present system of regulated monopolies that has worked well for many years. However, it also curtailed investment in the electric power industry by prohibiting investment from outside entities. Accordingly, the repeal of PUHCA, as outlined in S.475, is recommended. Repeal will assist in the “unbundling” process and encourage investment in the industry, especially in the power grid and distribution portions that are currently suffering from a lack of new capital.

However, the reform of PURPA, as outlined by the National Energy Policy is not recommended at this time. One must be aware that power grid companies, due to their natural monopoly status are not “price takers.” Prices for these regional monopolies are initially set at the point where marginal cost is equal to marginal revenue. However, they also are set on the downward falling portion of their average total cost curve. In other words, they can “take it” and still make large profits. In sum, the social benefit of using excess fuels (required by non-utilities for other reasons) to generate power is a benefit to society that ought not be thrown out. In sum, section 216 in Title II of S.475, which waters down portions of PURPA, should be taken out of the bill.

The elimination of PUHCA along with the continuation of PURPA, EPACT and FERC Orders 888, 889 and 2000 all point to a more competitive industrial structure. Power generation is already deregulated. The transmission grid and distribution systems will continue to evolve, assuming that these three FERC orders are not rescinded. If a system of bidding and/or franchise development for the operation of grid systems is put into effect, the overall industry will attract more investment and become more competitive. However, the grid and distribution systems will still require some level of economic regulation, given the requirements that PURPA and EPACT impose and the fact that they will retain

natural monopoly characteristics.

## **FINAL CONCLUSION**

Integral to every sector of the economy, energy is the only industry and commodity declared as a vital national interest. As the world's only superpower, largest economy and principal driver of global economic growth, the United States will continue to see energy as a vital national and global interest for the foreseeable future.

Of the fuels that comprise the energy industry, oil, coal, and increasingly natural gas will continue to be the fuels of choice. Industrialized nations have built their economies on these fossil fuels since they are relatively inexpensive and abundant. Developing nations will also be largely dependant on fossil fuels for increasing energy demand. This worldwide increasing demand poses two challenges – environmental degradation and the affordable access to energy.

The Kyoto Protocol attempted a solution to environmental degradation; however, unrealistic targets will lead to renegotiation in the future. In the meantime, energy production is shifting toward cleaner technology to meet environmental concerns. This shift is causing tremendous changes in the energy industry.

The second challenge is retaining access to diversified fuel sources at affordable prices. This challenge is threatened daily by regional instability and geopolitical realities. The geographically imbalanced distribution of energy resources makes it inevitable that shortages will occur that can only be resolved through diplomacy and trade, or failing that, through military power.

Alternate energy sources offer long-term hope but will not make a significant contribution to near term energy production. Nuclear energy is at a crossroads of stable production, stalled by safety concerns. Clean fossil fuels offer partial, technological solutions that could provide mid-term alternatives for improving the environment and security. Natural gas, increasingly the fuel of choice, will likely be the primary bridge to future electricity generation and subsequently the hydrogen economy. Oil will dominate the energy mix for the next 15 – 20 years as consumption grows with the economy.

Only through increasingly efficient use and diversity in geographical supply, will the U.S. and other nations reduce the effect of emissions and their dependency on unstable regions for their oil supplies. In the past, this was largely achieved through government intervention – regulation, legislation, and occasionally war. The future answers are in a deregulated, free market economy that trades energy and its emissions.

Finally, the U.S. will not become energy independent. Our growing economy and population combined with domestic natural resources depletion force our reliance on the global energy market as the best solution to meet our needs. The United States and other nations are subject to prices set in the world market, irrespective of the amount of indigenous supply. The competitive nature of the markets will naturally seek to balance supply and demand, creating a global web of trade relationships. These interdependencies that build diversity are the essence of energy security, not only for the United States, but also for other industrialized nations.

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